Verification of Ocean Forecasts with Spectral Analysis

Christine Pequignet

Met Office

The increasing use of machine learning techniques in ocean forecasting has highlighted the need for novel verification methodologies capable of assessing forecast skill using metrics that are independent of those employed during model training. In particular, processed-oriented metrics have been identified as a priority for evaluating the physical realism of data-driven forecasting systems. The development of new verification metrics also offers the opportunity to define alternative loss functions for machine-learning-based emulators, thereby supporting further improvements in forecast performance.

To address this need, we are developing a spectral analysis framework for the evaluation of ocean forecasts. A set of python packages has been selected and integrated to compute spatial and temporal spectra from both observational and forecast datasets. These spectral diagnostics provide insight into the scales of variability represented within each dataset and how this might evolve through the forecast and help identify the spatio-temporal periods that should be considered when averaging to derive robust verification metrics.

The proposed metrics are based on differences between the spectra of reference and forecast datasets. Additional metrics can be derived from cross-spectral analyses, which quantify not only the coherence between datasets but also their phase relationships. Spectral metrics are dependent on the shape of the underlying spectra and differ across variables and between spatial and temporal domains.

Spectral metrics are being applied to the evaluation of sea surface temperature forecasts and are used to compare the performance of different forecasting systems. This approach provides a process-oriented assessment of forecast skill, complementing traditional verification measures and offering new perspectives for the evaluation of both physics-based and machine-learning forecasting systems.